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GEOLOGY, ENERGY, AND MINERAL (GEM) RESOURCE ASSESSMENT OF THE McCULLOUGH PEAKS GEM RESOURCE AREA (GRA), WYOMING, INCLUDING THE McCULLOUGH PEAKS WILDERNESS STUDY AREA (WY-010-335)

PHASE I

Contract No. YA-553-CT2-1055

Prepared for:

U.S. Bureau of Land Management

Prepared by:

Tetra Tech, Inc.
Pasadena, California

August 1983

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EXECUTIVE SUMMARY

The U.S. Bureau of Land Management (BLM) has adopted a two-phase procedure for the integration of geologic, energy, and mineral (GEM) resources data concerning Wilderness Study Areas (WSAs). To facilitate this review, certain WSAs with similar geologic environments and mineral characteristics have been grouped together into larger GEM Resource Areas (GRA). Using these guidelines, the McCullough Peaks WSA was grouped into the larger McCullough Peaks GRA. This report, which terminates the Phase I activities for the McCullough Peaks GRA, is an evaluation and interpretation of existing data concerning the GEM resource potential in the WSA.

The McCullough Peaks GRA contains one WSA, the McCullough Peaks WSA (WY-010-335). The McCullough Peaks WSA is located in the BLM's Cody Resource Area, Worland District, Wyoming.

The McCullough Peaks WSA is considered to have a moderate favorability based on abundant direct and indirect evidence for the potential occurrence of oil and gas (classified 3D); this classification is based upon the presence of favorable geologic horizons beneath the WSA and within the surrounding region for the accumulation of oil and gas. The potential occurrence of paleontologic resources within the WSA is considered moderately high. There exists quantitatively minimal direct evidence to support a low favorability classification for the potential occurrence of other GEM resources in the study area (classified 2C). This classification is based in part on the geologic environments and the inferred geologic processes that have been identified within the WSA.

Additional geologic investigations would help supplement the GEM resource evaluation of the McCullough Peaks GRA. An examination of available well logs would help determine whether suitable geologic horizons are present in the study area for the accumulation of hydrocarbons. A moderate amount of geologic information exists which should be reviewed in depth by BLM personnel to gain additional insight into the potential occurrence of GEM resources prior to making wilderness decisions.

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GEM RESOURCE AREA

McCULLOUGH PEAKS

1.0 INTRODUCTION

1.1 Purpose of Study

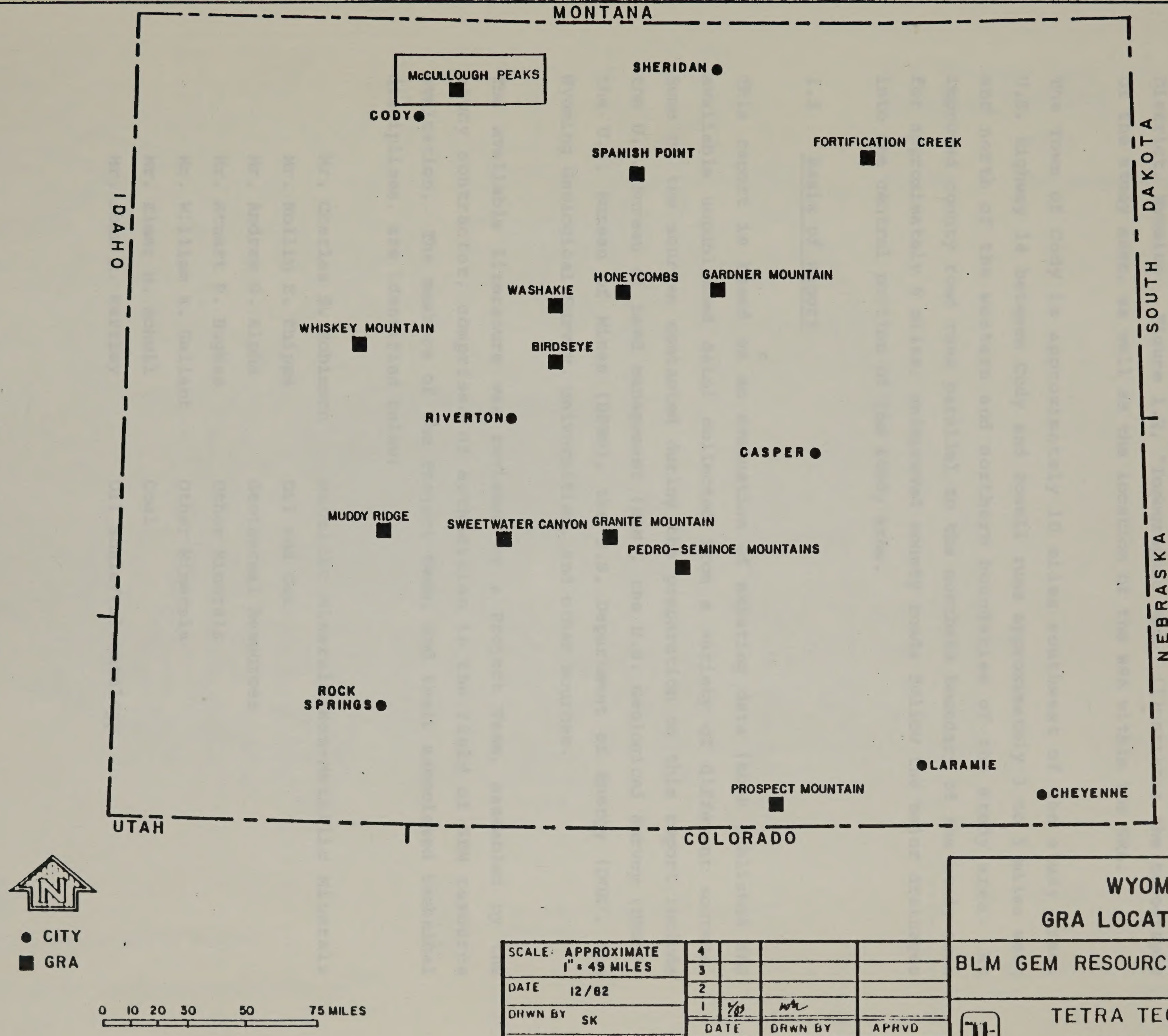
The U.S. Bureau of Land Management (BLM) has adopted a two-phase procedure for the integration of geologic, energy, and mineral (GEM) resources data concerning Wilderness Study Areas (WSAs). Phase I consists of a review and evaluation of existing data, resulting in an interpretation of the GEM resource potential in the WSA. Phase II is designed to generate only the additional data required to support the GEM resource recommendations presented during Phase I. To facilitate this review, certain WSAs with similar geologic and mineral characteristics have been grouped together into larger GEM Resource Areas (GRA). Using these guidelines, the McCullough Peaks WSA was grouped into the larger McCullough Peaks GRA. This report, which terminates the Phase I activities for the McCullough Peaks GRA, is an evaluation and interpretation of existing data concerning the GEM resource potential in the McCullough Peaks WSA.

The GEM resource evaluations for this study were performed by Tetra Tech, Inc. for the U.S. Bureau of Land Management, under Solicitation No. YA-553-CT2-1055. This study was completed in August, 1983.

1.2 Location and Access

This GEM report covers the area identified as the McCullough Peaks GEM Resource Area (GRA); the geographic location of the study area is shown in Figure 1.1, "GRA Location Map."

The McCullough Peaks GRA contains one WSA, the McCullough Peaks WSA (WY-010-335). The McCullough Peaks WSA contains approximately 25,210 acres, and is located between 44° 40'-45' north latitude and between 108° 40'-55' west longitude, Park County, Wyoming. The WSA occurs within parts of Townships (T)



WYOMING
GRA LOCATION MAP

BLM GEM RESOURCES ASSESSMENT

TETRA TECH INC.
PASADENA, CALIFORNIA

FIGURE 1.1

SCALE: APPROXIMATE 1" = 49 MILES
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53-54 North (N), Range (R) 99-100 West (W), 6th Prime Meridian (P.M.). The McCullough Peaks WSA is located within the BLM's Cody Resource Area, Worland District, Wyoming. Figure 1.2, "Topographic Map," illustrates the topography of the study area, as well as the location of the WSA within the GRA.

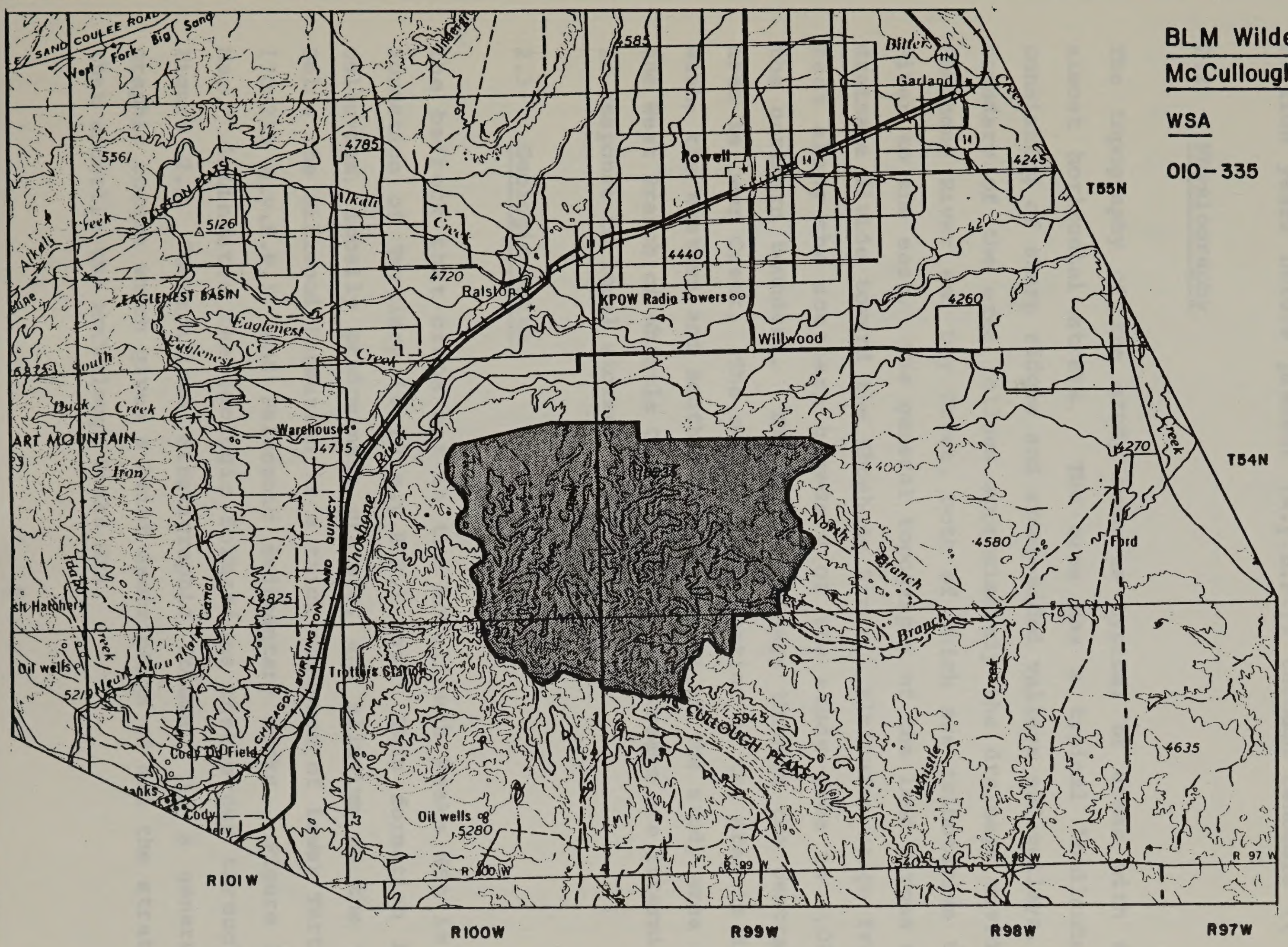
The Town of Cody is approximately 10 miles southwest of the study area. U.S. Highway 14 between Cody and Powell runs approximately 3 to 5 miles west and north of the western and northern boundaries of the study area. An improved county road runs parallel to the northern boundary of the study area for approximately 6 miles; unimproved county roads follow the major drainages into the central portion of the study area.

1.3 Basis of Report

This report is based on an evaluation of existing data (both published and available unpublished data) collected from a variety of different sources. Some of the sources contacted during the preparation of this report include the U.S. Bureau of Land Management (BLM), the U.S. Geological Survey (USGS), the U.S. Bureau of Mines (USBM), the U.S. Department of Energy (DOE), the Wyoming Geological Survey, universities, and other sources.

The available literature was reviewed by a Project Team, assembled by the study contractor, comprised of authorities in the field of GEM resource evaluation. The members of the Project Team, and their associated technical disciplines, are identified below:

Mr. Charles S. Robinson	Metallic Minerals/Non-Metallic Minerals
Mr. Rollin E. Phipps	Oil and Gas
Mr. Andrew G. Alpha	Geothermal Resources
Mr. Stuart P. Hughes	Other Minerals
Mr. William A. Gallant	Other Minerals
Mr. Elmer M. Schell	Coal
Mr. John A. Hartley	Oil Shale/Paleontology



BLM Wilderness Study Areas Included in the McCullough Peaks GRA

WSA	NAME	ACREAGE
010-335	McCullough Peaks	25,210

(USGS, n.d.)

NOTE: Contours in 200 ft. Intervals.

5 4 3 2 1 0 3 6 Miles

5 4 3 2 1 0 5 10 Kilometers

▨ Approximate Boundary of Wilderness Study Area

SCALE	1" = 4 MILES 1:250,000	4			
		3			
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McCullough Peaks GRA, Wyoming

TOPOGRAPHIC MAP

BLM GEM RESOURCES ASSESSMENT

REGION 6 WYOMING and MONTANA

TETRA TECH INC

FIGURE 1.2

2.0 GEOLOGY

2.1 General

The McCullough Peaks area is located on the axis and near the northern end of the Bighorn Basin. The Bighorn Basin is a structural basin filled with a thick sequence of sedimentary rocks that range in age from Paleozoic (< 600 million years before present [m.y.B.P.]) through Cenozoic (< 70 m.y.B.P.).

2.2 Physiography

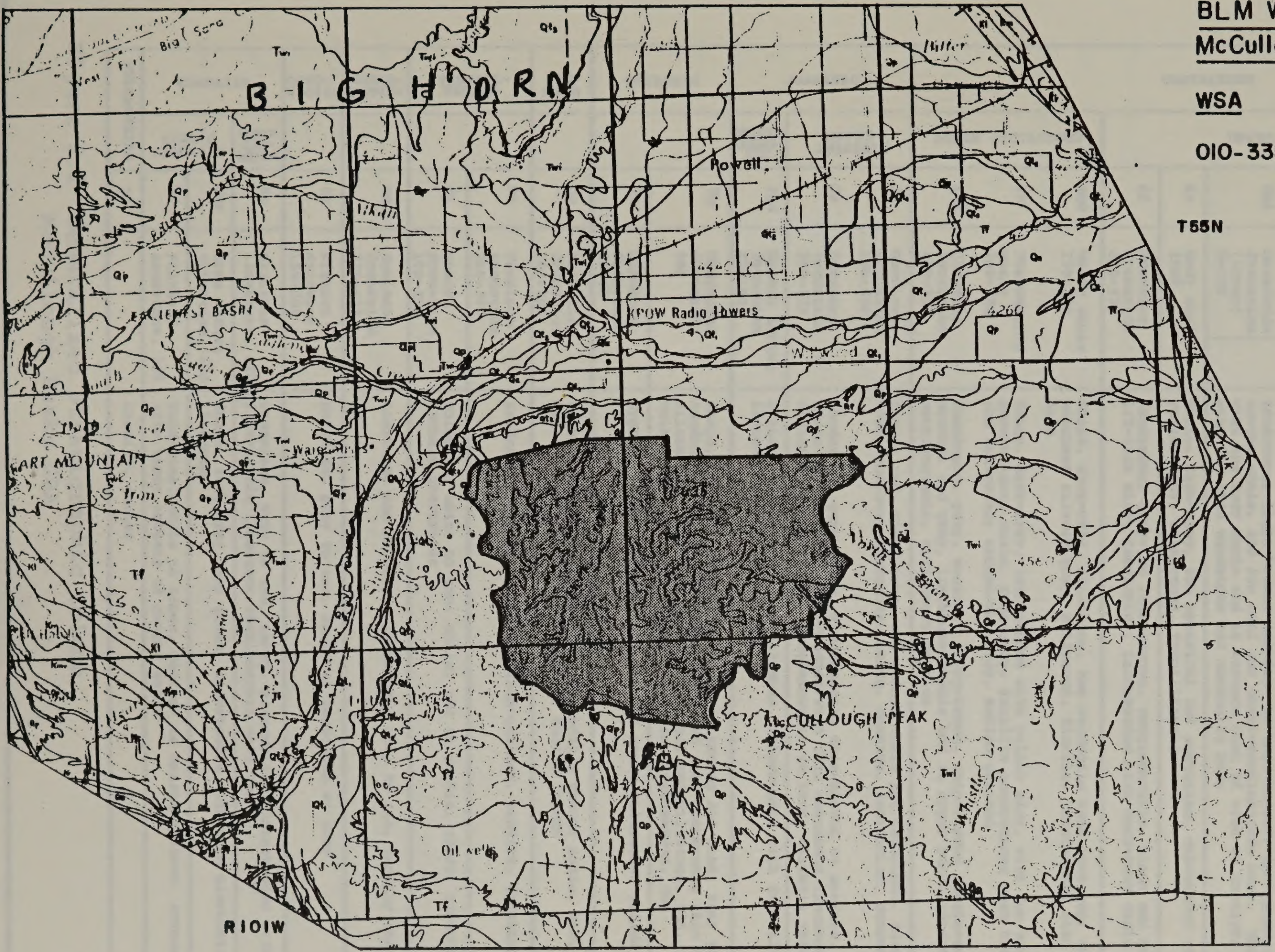
The topography of the study area is typical of areas with easily eroded, almost horizontal strata. The area has a typical "badlands" topography, consisting of sharp ridges and steep-sided valleys and gulleys. The southern boundary of the area follows approximately the drainage divide between the Shoshone River and Dry Creek, both of which are tributaries to the Bighorn River to the east. The general topography of the land slopes north from the drainage divide toward the Shoshone River. Altitudes range from about 6,500 feet along the southern boundary of the study area to 4,000 feet along the northern boundary. The major drainage through the central part of the area is Deer Creek. The northeastern portion of the area is drained by Roan Wash; the eastern and southeastern portions of the study area are drained by the West Branch of Whistle Creek. All these streams are intermittent and flow in response to local storms.

2.3 Geologic Units

The bedrock that crops out in the McCullough Peaks WSA is the Willwood Formation of Tertiary (< 70 m.y.B.P.) age. This formation is overlain by colluvium, locally predominant gravels, and alluvium on the valley floors. Below the Willwood Formation is a thick sequence of Lower Tertiary, Mesozoic (70-225 m.y.B.P.), and Paleozoic sedimentary rocks. Figure 2.1, "Geologic Map," delineates the geologic formations that occur throughout the GRA. Figure 2.2, "Generalized Stratigraphic Column," is a generalized stratigraphic column which gives a brief description of all the stratigraphic units that underlie the McCullough Peaks GRA.

BLM Wilderness Study Areas Included in the McCullough Peaks GRA

WSA	NAME	ACREAGE
010-335	McCullough Peaks	25,210



▨ Approximate Boundary of Wilderness Study Area

5 4 3 2 1 0 3 6 Miles
5 4 3 2 1 0 5 10 Kilometers

SCALE	1" = 4 MILES 1:250,000
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1	3/83	SK	

REVISIONS

(PIERCE, 1978)

McCullough Peaks GRA, Wyoming

GEOLOGIC MAP

BLM GEM RESOURCES ASSESSMENT
REGION 6 WYOMING and MONTANA

TETRA TECH INC

2.1

SYSTEM	SERIES	SYMBOL	FORMATION, THICKNESS, FT	GENERAL LITHOLOGIC DESCRIPTION
QUATERNARY		Qp/ Qt	Pediment/ Terrace Deposits	Silt, sand, gravel and boulders deposited by streams that eroded the area
TERTIARY	LOWER EOCENE	Twi	Willwood formation 500+	Shale and siltstone, gray-green to red, some carbonaceous shale, interbedded with few thin sandstones; sandstones, light-gray, crossbedded, contains thin beds of carbonaceous shale with plant fragments
	PALEOCENE	Tf	Fort Union formation 1000+	Shale, gray, containing numerous ironstone concretions, interbedded with thin sandstones; sandstone and shale; sandstone, gray to brown with shale and coal beds
CRETACEOUS	UPPER CRETACEOUS	Kl	Lance formation 700-1000	Sandstone, brown, interbedded with gray shale; dinosaur bone fragments; sandstone and gray shale, interbedded with carbonaceous shale; sandstone, light-gray, massive, crossbedded, contains numerous large oval calcareous sandstone concretions
		Kmt	Meeteetse formation, 410	Shale and sandstone, thin-bedded, interbedded with coal and bentonite; sandstone, gray, fine-grained, poorly consolidated, interbedded with shale and bentonite
		Kmu	Mesaverde formation (upper), 700	Sandstone, white medium- to fine-grained, interbedded with some carbonaceous shale and coal; sandstone and shale, interbedded; sandstone, light-brown, massive- to thin-bedded
		Kc	Cody shale 250	Shale, drak-gray, interbedded, with few thin sandstones
		Kml	Mesaverde formation (lower) 0-300	Sandstone, light-brown, massive- to thin-bedded, interbedded with gray and carbonaceous shale, and few coal and chert-conglomerate beds. This unit intertongues with the Cody shale and in eastern part of area it consists of dark-gray shale with few thin sandstone and bentonite beds
		Kc	Cody shale 2800	Shale, dark-gray, few spherical and septatian, calcareous concretions; shale, yellow-gray, calcareous, fossiliferous
		Kf	Frontier formation 430-570	Sandstone, gray- to light-brown, conglomeratic, black and brown chert pebbles 1/2-inch size, lenticular, interbedded with dark-gray shale
	LOWER CRETACEOUS	Kmr	Mowry shale 270-290	Shale, dark-gray, siliceous, two bentonite beds near top; shale, dark-gray, weathers silvery gray, siliceous, fissile, interbedded with thin white clay beds
		Kt	Thermopolis shale 340-380	Shale, dark-gray, interbedded with yellow clay, with few zones of ironstone concretions; shale, dark-gray, dahllite concretions near base; shale, dark-gray, and bentonite; sandstone, gray, medium grained
		Kcl	Cloverly formation 190-230	Sandstone, gray, weathers rusty-brown, thin-bedded ripple-marked; shale red, maroon, and gray, limestone-cobble bed in upper part; sandstone, gray crossbedded, conglomeratic, with chert pebbles
JURASSIC	UPPER JURASSIC	Jm	Morrison formation 190-250	Shale, red, pink, gray, and green; shale and sandstone, thin-bedded; some sandstone beds, massive; sandstone, white, massive, lenticular, crossbedded
		Js	Sundance formation 200-330	Sandstone, gray-green, glauconitic, thin-bedded to massive, interbedded with green shale; shale, gray, interbedded with thin coquinoid limestones; sandstone, tan, medium-grained, locally conglomeratic at base, slightly calcareous
	MIDDLE JURASSIC	Jgs	Gypsum Spring formation 80-140	Shale, red and green, gypsiferous, interbedded with few siltstone and gray limestones; gypsum, white
TRIASSIC		TRc	Chugwater formation 960	Shale, red, interbedded with red siltstone and pink, very fine-grained sandstone; sandstone, reddish-brown; interbedded with occasional thin beds of red shale and siltstone; limestone, blue-gray; shale and siltstone, red, interbedded with few thin gypsum beds; siltstone and shale, interbedded, red
		TRd	Dinwoody formation 40-60	Gypsum, white, interbedded with red shale siltstone, yellow
PERMIAN		Pp	Park City formation 200-280	Limestone, gray, dolomitic, with nodular chert; shale, red, few thin limestone beds; limestone, gray, dolomitic, cherty layers
PENNSYLVANIAN		Pt	Tensleep sandstone 280-390	Sandstone, white to bluff, medium-grained, massive, crossbedded
		Pa	Amsden formation 190-290	Dolomite, white to tan; shale, red to purple, sandy; sandstone, gray to brown, locally quartzitic
MISSISSIPPIAN		Mm	Madison formation 325-425	Limestone and dolomitic limestone, gray to tan, locally cherty
ORDOVICIAN		Ob	Bighorn dolomite 150-200	Dolomite, gray to tan, massive; sandstone at base
CAMBRIAN	UPPER CAMBRIAN	Єg	Gallatin limestone, 440	Limestone, gray to tan, sandy, glauconitic, interbedded with gray to green shale; flat-pebble limestone conglomerate near top
	MIDDLE CAMBRIAN	Єgv	Gros Ventre formation, 470	Shale, red, gray, and green, interbedded with thin glauconitic sandstone and limestone
		Єf	Flathead sandstone, 200	Sandstone, white to brown, medium- to coarse-grained, arkose at base, interbedded with minor amounts of purple shale
PRECAMBRIAN		pЄ		Granite, gneiss

Figure 2.2 Generalized Stratigraphic Column
McCullough Peaks GRA

2.3.1 Bedrock Units

The bedrock in the McCullough Peaks WSA is the Willwood Formation. This formation crops out at the surface within the study area. The Willwood Formation (early Miocene [11-25 m.y.B.P.]) consists predominantly of variegated clay, sandstone, and shale. Carbonaceous shale, containing thin, lenticular coal seams, occurs locally. The sandstone beds in the lower part of the formation may be conglomeratic. The maximum thickness of the Willwood Formation is estimated to be about 1,000 feet (Pierce, 1978).

2.3.2 Surficial Deposits

The surficial deposits in the study area include colluvium, pediment gravels, and alluvium. Thin colluvium, derived from the weathering of the bedrock, mantles most of the area except for the steep slopes adjacent to deep valleys or gulleys. Remnants of old terraces, or pediments, when streams were at much higher levels than present, cap some of the hills. These pediment deposits of sand and gravel are most abundant in the northeast part of the study area. Thin alluvial deposits, consisting primarily of fine-grained sand and silt, form the modern floodplains of most of the streams. Thin deposits of Paleozoic colluvium mantles the upland surface as a lag deposit from erosion of the autochthonous upper Heart Mountain thrust plate (Barrell, 1983).

2.4 Structural Geology

The McCullough Peaks WSA is near the center of the axis of the Bighorn Basin. The basin is primarily a Laramide structure and the Willwood Formation, which outcrops in the study area, is a result of the uplift and erosion of the adjacent mountain ranges. In general, the beds of the Willwood Formation are horizontal or dip gently, less than 5°, to the northeast. No major faults have been identified within the area (Pierce, 1978). An autochthonous block of Paleozoic rock has been eroded from the area as part of the upper plate of the Heart Mountain thrust (Barrell, 1983).

2.5 Engineering Geology

No major geologic hazards exist within the study area. The shales, or claystones, of the Willwood Formation are probably expansive in part and not suitable for construction without testing and proper engineering design. Colluvial slump, or small landslides, could occur in the study area from undercutting colluvial slopes. Where thicker sandstone forms small cliffs, rockfalls may occur because of erosion of soft shales below the sandstone beds.

2.6 Paleontologic Resources

The Willwood Formation is noted throughout this region for the abundance of vertebrate fossils (Jepsen, 1930). Specific sites within the GRA for the occurrence of vertebrate fossils have not been identified. This would require more detailed paleontologic studies than have been conducted to date. The WSA has significant potential for the occurrence of vertebrate Paleontologic resources.

2.7 Historical Geology

The geologic history of the McCullough Peaks area is similar to that of the northern Rocky Mountains. The basement Precambrian (> 600 m.y.B.P.) rocks consist of metaigneous and metasedimentary rocks, the history of which is not well understood. At the end of Precambrian time, and throughout the Paleozoic era, there were repeated advances and retreats of the sea. Marine deposits of sandstone, shale, and limestone were formed. At the end of the Paleozoic era, marine, marginal marine (evaporites) and terrestrial red-bed deposits were formed as seas fluctuated back and forth over the area. During the deposition of the Paleozoic rocks, stratigraphic traps for hydrocarbons developed along facies changes, unconformities, and lithologic boundaries. Marine conditions returned in Jurassic (135-180 m.y.B.P.) time, only to retreat at the end of the Jurassic period. A major marine invasion started in early Cretaceous (70-135 m.y.B.P.) time, and continued until the start of the Laramide orogeny near the end of the Cretaceous period. The Tertiary period was a period of

repeated uplift, accompanied by folding, thrusting, and high-angle faulting, and the deposition of thick terrestrial sediments in the intermountain basins. The structural activity formed traps for hydrocarbon accumulation. Volcanism was active in the mid to late Tertiary time, and thick volcanic ash was distributed widely. The Quaternary (2-3 m.y.B.P.) period is noted for the widespread glaciation in the mountains; glacial outwash deposits along the flanks of the mountains; and the erosion of rock forming the topographic landscapes seen today.

3.0 ENERGY AND MINERAL RESOURCES

3.1 General

There are no known energy or mineral resources in the McCullough Peaks WSA. The only potential resources of any significance in the area are oil and gas. Coal probably occurs at great depths.

Figure 3.1, "Mineral Occurrence Map," illustrates the locations of any known past and present mines, and occurrences of mineral deposits and GEM resources within the GRA. The sources of information for this figure are the USGS' Computerized Resource Information Bank (CRIB); the USBM's Minerals Availability System (MILS); and Petroleum Information Corporation (PI).

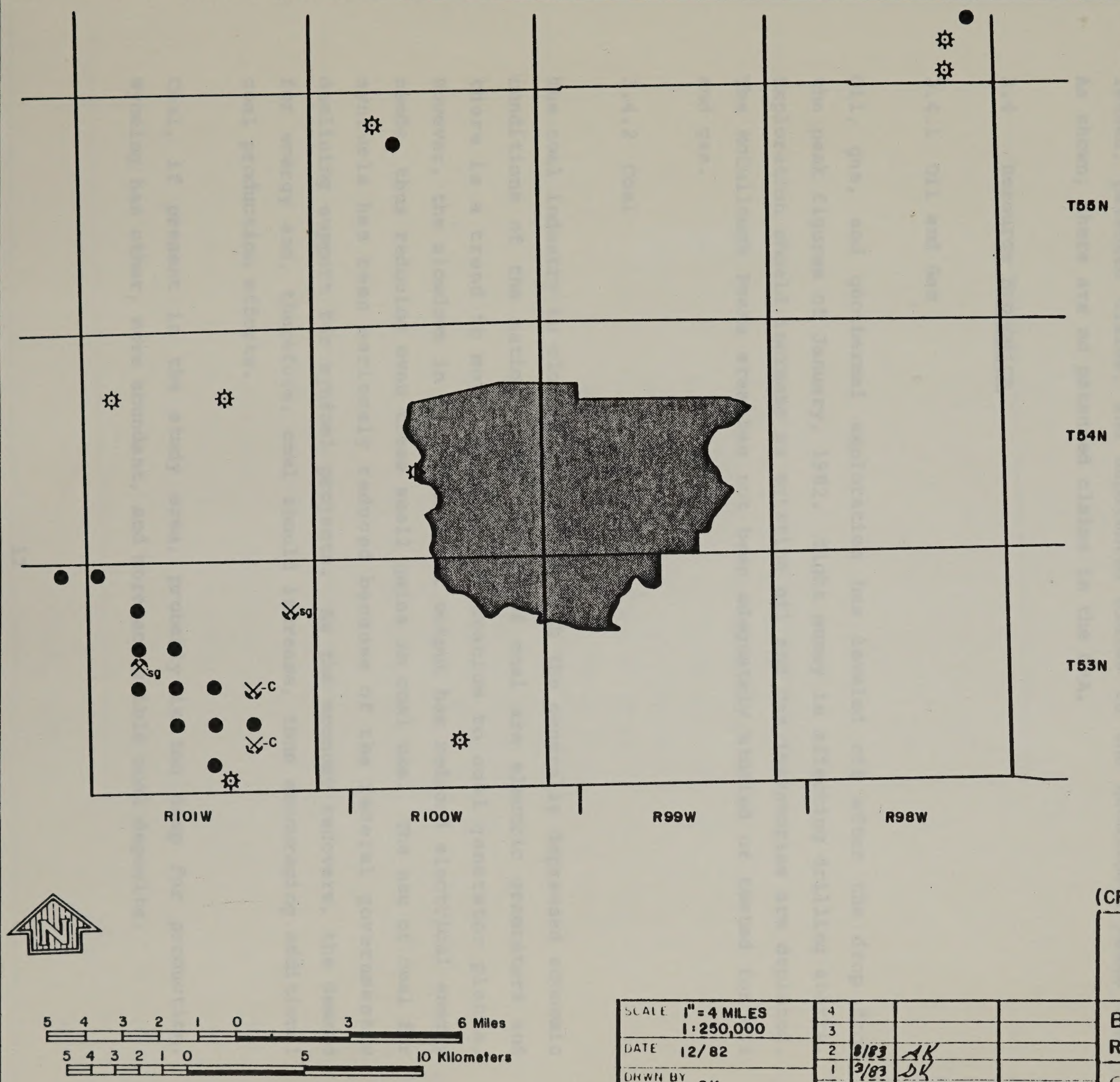
3.2 Potential Resources

Several holes have been drilled in or adjacent to the McCullough Peaks area searching for oil and gas. Cretaceous through Paleozoic age rocks underlie the area. In other areas of the Bighorn Basin, oil and gas are produced from structural and/or stratigraphic traps in these units (PI, 1982) (Figure 3.1).

Coal in the Bighorn Basin occurs in the Meeteetse, Fort Union, Lance and Mesaverde Formations. These units underlie the Willwood Formation and could contain coal. No such occurrences, however, have been reported. The depths of these formations preclude exploration or development at present.

BLM Wilderness Study Areas Included in the McCullough Peaks GRA

WSA	NAME	ACREAGE
010-335	McCullough Peaks	25,210



- ● Oil Well
- ☼ Gas Well
- ✹ Oil & Gas Well
- ⚒ Mine
- ⚒ Inactive Mine
- ■ Ore Body
- ◧ Deposit
- ▨ Approximate Boundary of Wilderness Study Area

COMMODITY

c	Coal
sg	Sand and Gravel

(CRIB,1982; MILS,1982; PI,1982)

McCullough Peaks GRA, Wyoming

MINERAL OCCURRENCE MAP

BLM GEM RESOURCES ASSESSMENT
REGION 6 WYOMING and MONTANA

TETRA TECH INC.
PASADENA, CALIFORNIA

FIGURE 3.1

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The pediment deposits contain sand and gravel. These deposits could be used locally as sources of base course or surfacing materials for roads.

3.3 Land Status

Oil and gas leases blanket much of the McCullough Peaks WSA, thus indicating interest in potential hydrocarbon accumulations within the area. Figure 3.2, "Claim and Lease Map," illustrates the locations of any oil and gas leases, patented claims, and unpatented claims in the McCullough Peaks GRA. As shown, there are no patented claims in the GRA.

3.4 Resource Economics

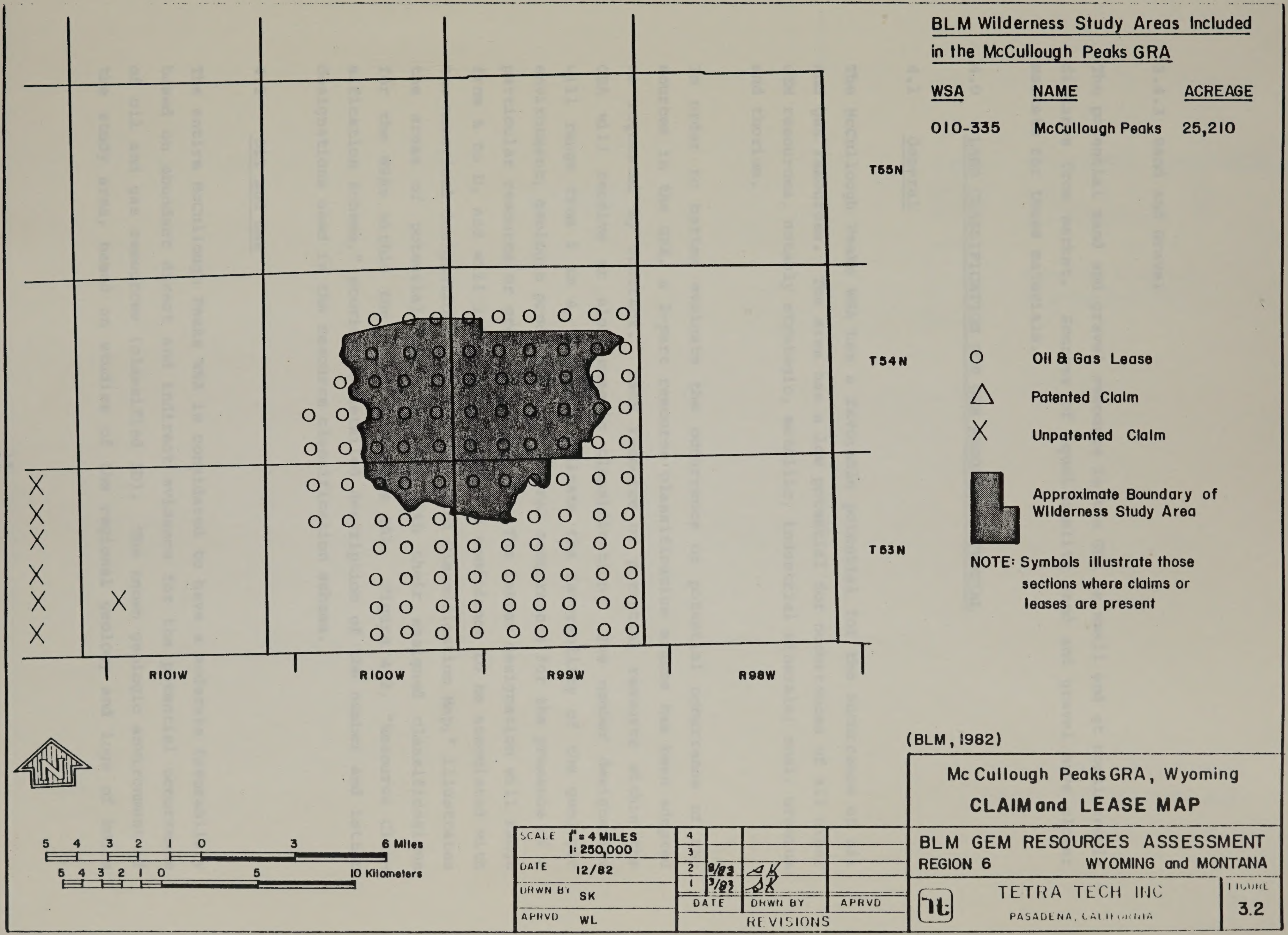
3.4.1 Oil and Gas

Oil, gas, and geothermal exploration has leveled off after the drop from the peak figures of January, 1982. Tight money is affecting drilling starts. Exploration should increase as existing oil and gas inventories are depleted. The McCullough Peaks area has not been adequately studied or tested for oil and gas.

3.4.2 Coal

The coal industry is closely associated with the generally depressed economic conditions of the nation. Major users of coal are electric generators and there is a trend to move from oil and uranium to coal generator plants. However, the slowdown in U.S. industrial output has reduced electrical energy needs, thus reducing even these small gains in coal use. The use of coal for synfuels has been seriously reduced because of the federal government's declining support for synfuel projects. As the economy recovers, the demand for energy and, therefore, coal should increase, thus encouraging additional coal production efforts.

Coal, if present in the study area, probably is too deep for production. Wyoming has other, more abundant, and more accessible coal deposits.



BLM Wilderness Study Areas Included in the McCullough Peaks GRA

WSA	NAME	ACREAGE
010-335	McCullough Peaks	25,210

- ○ Oil & Gas Lease
- △ Patented Claim
- X Unpatented Claim
- ▨ Approximate Boundary of Wilderness Study Area

NOTE: Symbols illustrate those sections where claims or leases are present

(BLM, 1982)

Mc Cullough Peaks GRA, Wyoming

CLAIM and LEASE MAP

BLM GEM RESOURCES ASSESSMENT
REGION 6 WYOMING and MONTANA

TETRA TECH INC
PASADENA, CALIFORNIA

FIGURE 3.2

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3.4.3 Sand and Gravel

The potential sand and gravel resource in the GRA is small and at considerable distance from market. Sources of equal quality sand and gravel have closer markets for these materials.

4.0 LAND CLASSIFICATION FOR GEM RESOURCE POTENTIAL

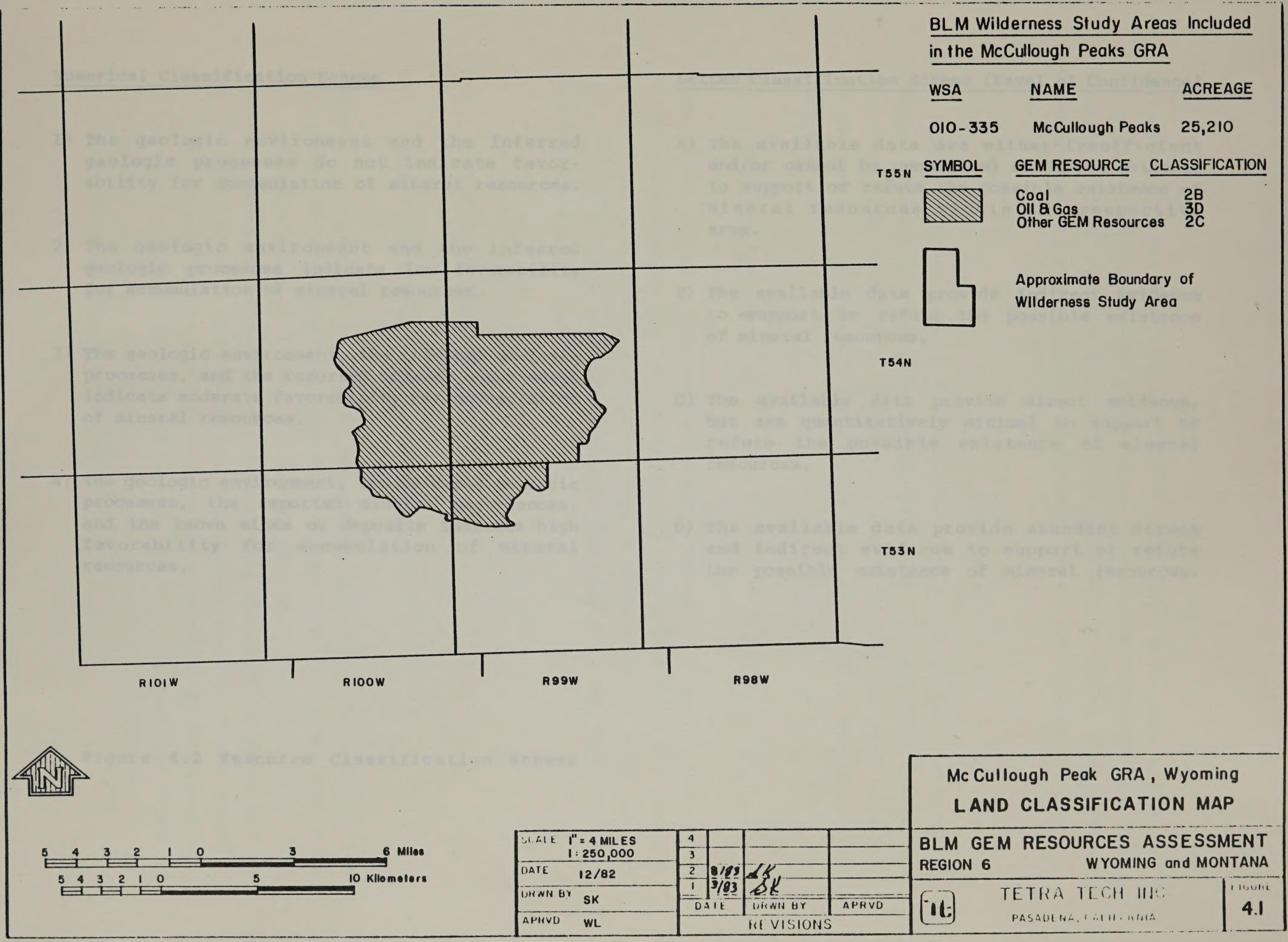
4.1 General

The McCullough Peaks WSA has a favorable potential for the occurrence of oil and gas resources. The area has a low potential for occurrences of all other GEM resources, notably strategic, metallic, industrial minerals; coal; uranium; and thorium.

In order to better evaluate the occurrence or potential occurrence of resources in the GRA, a 2-part resource classification scheme has been adopted as requested by contract. Each resource or potential resource within the GRA will receive an alpha-numeric classification. The number designation will range from 1 to 4, and will indicate the favorability of the geologic environment, geologic processes, and mineral occurrences for the presence of a particular resource or group of resources. The letter designation will range from A to D, and will indicate the level of confidence to be associated with the numerical designation. Figure 4.1, "Land Classification Map," illustrates the areas of potential GEM resources with their assigned classifications for the WSAs within the McCullough Peaks GRA. Figure 4.2, "Resource Classification Scheme," provides a detailed description of the number and letter designations used in the resource classification scheme.

4.2 Oil and Gas

The entire McCullough Peaks WSA is considered to have a moderate favorability based on abundant direct and indirect evidence for the potential occurrence of oil and gas resources (classified 3D). The known geologic environment of the study area, based on studies of the regional geology and logs of holes


BLM Wilderness Study Areas Included in the McCullough Peaks GRA
WSA
NAME
ACREAGE
010-335
McCullough Peaks
25,210
SYMBOL
GEM RESOURCE
CLASSIFICATION
Coal 2B
Oil & Gas 3D
Other GEM Resources 2C
Approximate Boundary of Wilderness Study Area
T55N
T54N
T53N
R101W
R100W
R99W
R98W
N
5 4 3 2 1 0 3 6 Miles
5 4 3 2 1 0 5 10 Kilometers
SCALE 1" = 4 MILES 1:250,000
DATE 12/82
DRWN BY SK
APRVD WL
4
3
2 8/83 SK
1 3/83 SK
DATE
DRWN BY
APRVD
REVISIONS
Mc Cullough Peak GRA, Wyoming
LAND CLASSIFICATION MAP
BLM GEM RESOURCES ASSESSMENT
REGION 6
WYOMING and MONTANA
TETRA TECH INC
PASADENA, CALIFORNIA
FIGURE
4.1

Numerical Classification Scheme

1) The geologic environment and the inferred geologic processes do not indicate favorability for accumulation of mineral resources.

2) The geologic environment and the inferred geologic processes indicate low favorability for accumulation of mineral resources.

3) The geologic environment, the inferred geologic processes, and the reported mineral occurrences indicate moderate favorability for accumulation of mineral resources.

4) The geologic environment, the inferred geologic processes, the reported mineral occurrences, and the known mines or deposits indicate high favorability for accumulation of mineral resources.

Letter Classification Scheme (Level of Confidence)

A) The available data are either insufficient and/or cannot be considered as direct evidence to support or refute the possible existence of mineral resources within the respective area.

B) The available data provide indirect evidence to support or refute the possible existence of mineral resources.

C) The available data provide direct evidence, but are quantitatively minimal to support or refute the possible existence of mineral resources.

D) The available data provide abundant direct and indirect evidence to support or refute the possible existence of mineral resources.

Figure 4.2 Resource Classification Scheme

drilled for oil and gas, indicate that stratigraphic units which produce oil and gas in other areas of the Bighorn Basin underlie the McCullough Peaks WSA. Detailed studies of logs have not been performed to define structural or stratigraphic traps suitable for the accumulation of hydrocarbons.

4.3 Coal

The McCullough Peaks WSA is considered to have a low favorability based on indirect evidence for the potential occurrence of coal resources (classified 2B); this classification is based upon the lack of a favorable geologic environment and the availability of only indirect evidence concerning coal resources.

4.4 Other GEM Resources

There exists quantitatively minimal direct evidence to support a low favorability classification for the potential occurrence of the other GEM resources in the study area (classified 2C). This classification is based in part on the geologic environment and inferred geologic processes that have been identified within the WSA.

5.0 RECOMMENDATIONS FOR FURTHER WORK

5.1 Work Recommended to Complete Data Base

A number of investigations could be implemented to generate additional data to supplement the conclusions of this Phase I report for the McCullough Peaks GRA. The logs of wells drilled for oil and gas in and adjacent to the area should be obtained. The locations of the wells should be carefully plotted and the logs studied. Based on these data, an experienced petroleum geologist should be able to make a prediction as to the probability of discovering oil and gas by drilling within the boundaries of the WSA. The same logs should be inspected for potential coal beds. Some coal drilling, if warranted by the drill hole study, is also recommended.

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